§16. Magnetic Reconnection and Global Structure of Substorm in Magnetosphere

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Magnetic reconnection is considered to play an important role in space phenomena such as substorm in the Earth's magnetosphere. Recently, Tanaka et al. reproduced substorm evolution process by numerical simulation with the global MHD code.[1] In the MHD framework, the dissipation model is used for modeling of the kinetic effects. They found that the normalized reconnection viscosity, one of the dissipation model employed there, gave a large effect for the substorm development though that viscosity was assumed to be a constant parameter. It is well known that magnetic reconnection is controlled by microscopic kinetic mechanism. Moritaka, Horiuchi and Ohtani investigated the roles of microscopic plasma instabilities on the violation of the frozen-in condition by examining the force balance equation based on explicit electromagnetic particle simulation for an ion-scale current sheet, and concluded that the growth of drift kink instability can create anomalous resistivity leading to the excitation of collisionless reconnection.[2] They estimated the effective resistivity based on the particle simulation data. Here, we perform substorm simulation by using the global MHD code with this anomalous resistivity obtained in their microscopic approach instead of the empirical resistivity model, and investigate the relationship between the substorm development and the anomalous resistivity model.

We use a global MHD code developed by Tanaka, [3] which involves the Hall term, and input the effective anomalous resistivity term evaluated from drift kink instability when configuration of the magnetic field is appropriate for magnetic reconnection in the magnetotail .[1]

Figures 1 and 2 are plasma pressure (color contour) and magnetic field (lines) at 44.0 minutes (Fig. 1) and 54.1 minutes (Fig. 2) after southward turning of the interplanetary magnetic field. It can be seen that magnetic reconnection occurred in magnetotail at 44.0 minutes (Fig. 1) and flux lope was formed at 54.1 minutes (Fig. 2). We found that the flux rope went tailward after that since its magnetic field was connected to interplanetary one. Figure 3 presents time variation of AU and AL indicies, which indicate an activity of ground geomagnetic field. Sudden decrease in the AL index meant occurrence of onset. It is known that degree of decrease highly depends on anomalous resistivity.

There are ambiguities such as the intensity of anomalous resistivity or region for input of anomalous resistivity in the MHD framework. We are going to investigate relation of the process of substorm evolution and anomalous resistivity model.

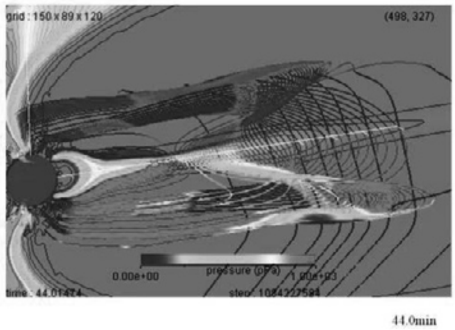

Fig. 1. Snapshot of magnetosphere at 44.0 minutes after southward turning of the interplanetary magnetic field. Color contour displays a plasma pressure, and lines represent the magnetic field. Colors of the lines indicate the intensity of the south-north component of the magnetic field.

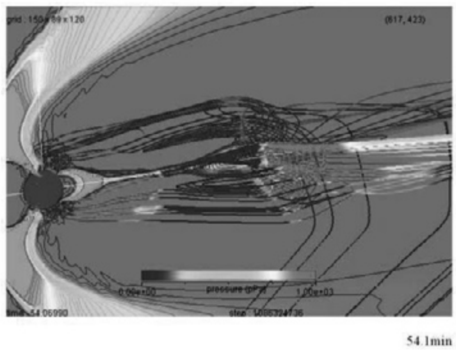

Fig. 2. Same as Fig. 1, but the time is 54.1 minutes after southward turning of the interplanetary magnetic field.

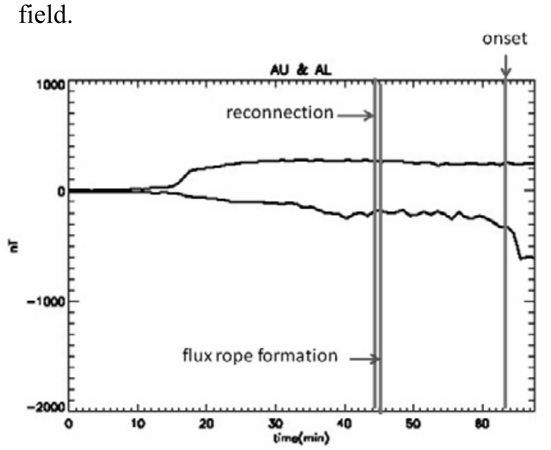

Fig. 3. Time variation of AU and AL indicies.

1) Tanaka, T., et al.: J. Geo. Res. **115** (2010) A05220
2) Moritaka, T., Horiuchi, R., and Ohtani, H.: Physics of Plasmas **14** (2007) 102109 1
3) Tanaka, T.: J. Comp. Physics **111** (1994) 381